TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 1 of

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Data Manager System 16 Data Storage System Host-n 14n \ 12 18 Host-1

FIGURE 1

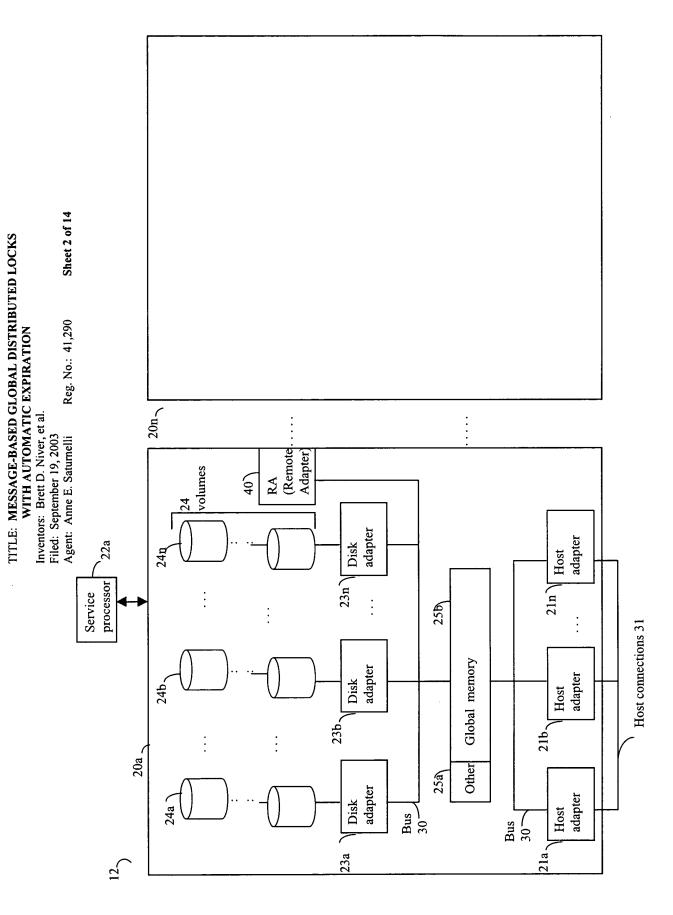


FIGURE 2

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS
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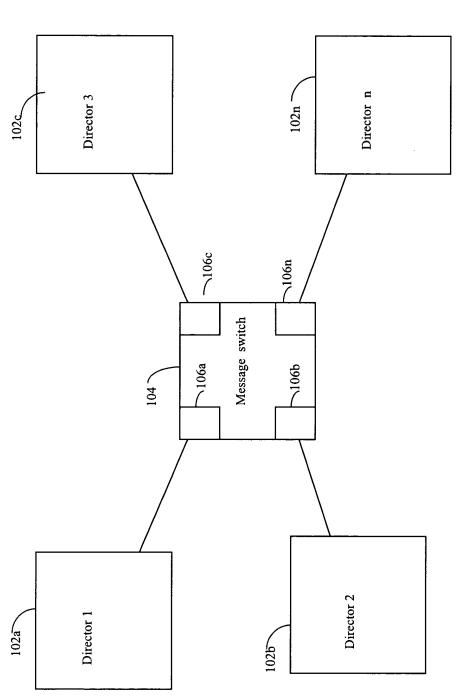


FIGURE 3

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 4 of

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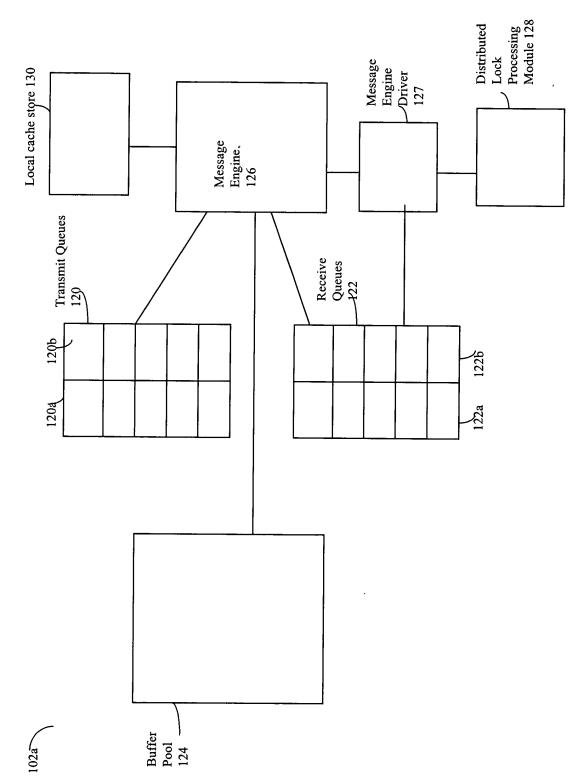


FIGURE 4

200

Sheet 5 of 14 208 indicating lock request response message Deny request by sending a lock denied. <u>8</u> grant time period Has the lock expired? Other processing. 220 206 \ YES current time + requested time Lock grant expiration time = YES Director receives lock request message. 8 Correct lock owner? been granted? Has the lock YES 210 203 202 <u>8</u>



indicating lock request response message

granted.

Grant request by sending a lock

212

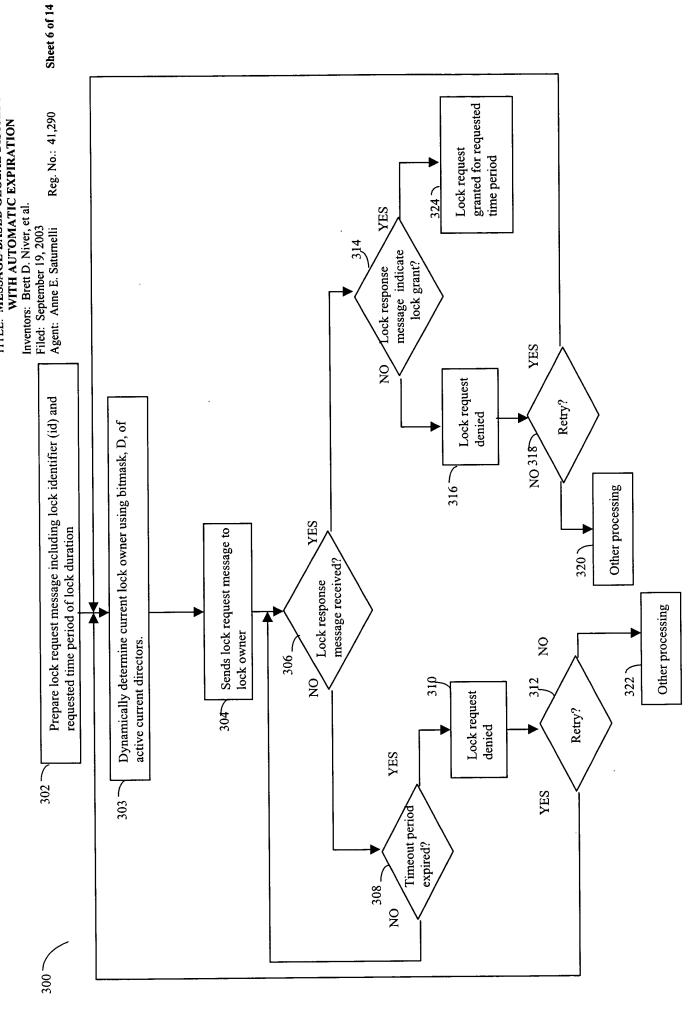


FIGURE 6

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS
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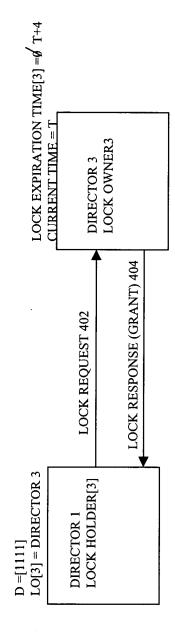
: Requested time Unused portion of lock duration 352b 354c) 356c MESSAGE DATA Lock identifier Lock Status (GRANT/ DENY) 354b \ 356b Message type = Lock Response Message type = Lock Request MESSAGE CODE 352a _ 354a \ 356a : 352_ 356 354 350 \

FIGURE 7

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 8 of

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DIRECTOR 2

DIRECTOR 4

FIGURE 8

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 9 of

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DIRECTOR 1 LOCK HOLDER[3]

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LOCK EXPIRATION TIME[3] = T+4 CURRENT TIME = T+1 LOCK RESPONSE (DENY) DIRECTOR 3 LOCK OWNER 3 **DIRECTOR 4** REQUEST 422 LOCK

DIRECTOR 2

D=[1111] LO[3] = DIRECTOR 3

FIGURE 9

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 10 of

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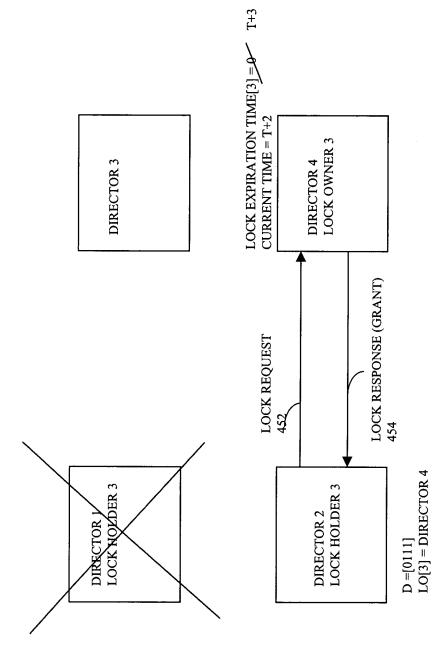


FIGURE 10

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500

D =[1111] LO[1] = DIRECTOR 1 DIRECTOR 3 LOCK HOLDER 1 LOCK RESPONSE LOCK REQUEST 502 (GRANT) 504 \ Lock expiration time[1] = A T+6 current time = T+4DIRECTOR 1 LOCK OWNER1

DIRECTOR 4

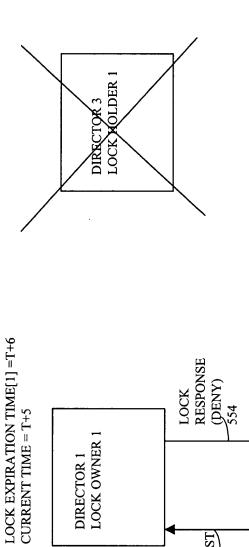
DIRECTOR 2

FIGURE 11

TITLE: MESSAGE-BASED GLOBAL DISTRIBUTED LOCKS WITH AUTOMATIC EXPIRATION Inventors: Brett D. Niver, et al. Filed: September 19, 2003 Agent: Anne E. Saturnelli Reg. No.: 41,290 Sheet 12 of

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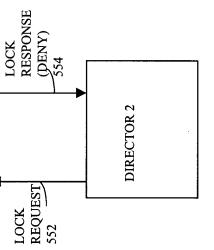
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DIRECTOR 1 LOCK OWNER 1

LOCK





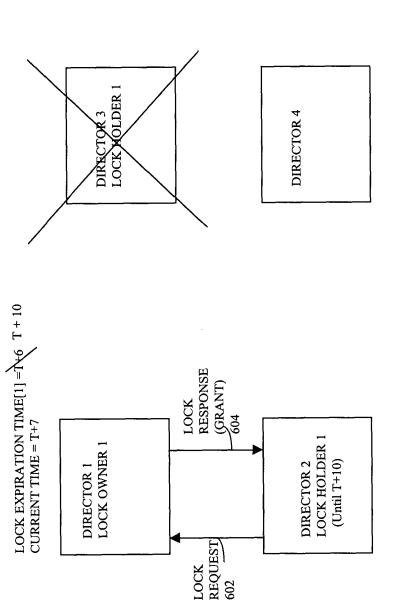
D =[1101] LO[1] = DIRECTOR 1



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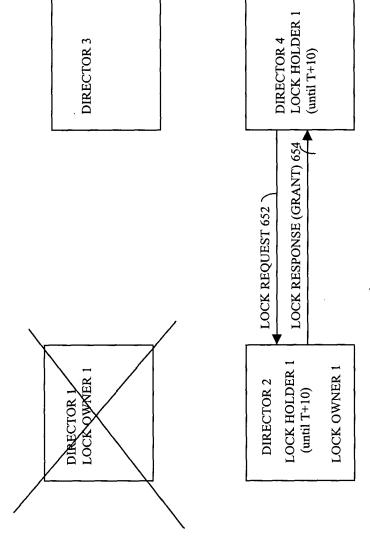


D =[1101] LO[1] = DIRECTOR 1

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D =[0111] LO[1] = DIRECTOR 2

 $\phi T + 10$

LOCK EXPIRATION TIME[1] =

CURRENT TIME = T+8

FIGURE 14